

## OUTLINE SHEET 1-4-1

### Meters and Gauges

#### A. Introduction

The measurement of different parameters such as temperature, pressure, and liquid level is essential for effective equipment operation and maintenance. This lesson will help you to learn how to read and interpret various meters and gages.

#### B. Enabling Objectives

- 1.14 **INTERPRET** readings on temperature, pressure and liquid level indicating devices.
- 1.15 **DESCRIBE** the various types and functions of temperature, pressure and liquid level indicating devices.

#### C. Topic Outline

- 1. Introduction
- 2. Definitions
- 3. Pressure Gauges
- 4. Temperature Measuring Devices
- 5. Liquid Level Indicators
- 5. Summary and Review
- 6. Assignment

## **ASSIGNMENT SHEET 1-4-2**

### Meters and Gauges

A. Introduction

This material is to be completed prior to the material being covered in class.

B. Enabling Objectives

Refer to enabling objectives in Outline Sheet 1-4-1.

C. Study Assignment

1. Read Fireman NAVEDTRA 12001, pages 11-1 to 11-15
2. Read Information Sheet 1-4-3

D. Study Questions

1. What is the difference between a simplex gauge and a duplex gauge?
2. Which thermometer is suitable for taking extremely high temperature readings?
3. What are the two major components of the magnetic float type level indicator?

## INFORMATION SHEET 1-4-3

### Meters and Gauges

#### A. Introduction

This information sheet details the parts and function of various meters and gauges.

#### B. Reference

Fireman NAVEDTRA 12001

Principles of Naval Engineering NAVEDTRA 12060

#### C. Information

##### I. Definition of Terms

- A. Pressure: the application of force upon a surface by an object or a fluid. Pressure is measured in force per unit area.
- B. Temperature: the measure of warmth or coldness within an object or substance with a reference to a standard value.
- C. Pounds Per Square Inch (PSI): A unit of pressure - the amount of force in pounds applied to one square inch.
- D. Atmospheric Pressure: the pressure that is exerted by the atmosphere. At sea level, atmospheric pressure is approximately 14.7 PSIA.
- E. Pounds Per Square Inch Gauge (PSIG): the pressure indicated by a gauge. The effect of atmospheric pressure is not included in the measurement.
- F. Pounds Per Square Inch Absolute (PSIA): gauge pressure plus atmospheric pressure.
- G. Vacuum: pressure that is lower than atmospheric pressure.
- H. Inches of Water (in H<sub>2</sub>O): A unit of pressure (or vacuum); length is taken as a measure equivalent to force or weight. For example; a reading of 1 in. H<sub>2</sub>O means that the exerted pressure is able to support a column of water 1 inch high.
- I. Inches of Mercury (in. Hg): A unit of pressure (or vacuum); length is taken as a measure equivalent to force or weight. For example; a reading of 1 in. Hg means that the exerted pressure is able to support a column of mercury 1 inch high.

##### II. Pressure Gauges - used to measure pressure.

- A. Depending on the application, pressure gauges are read in PSI, PSIG, PSIA, in. Hg or in.H<sub>2</sub>O. Gauges that read in PSI are assumed to mean PSIG.

- B. Bourdon Tube Gauges - a C-shaped, curved, or twisted tube that is open at one end and sealed at the other. The open end of the tube is fixed so it cannot move. The sealed end moves as pressure changes.
  - 1. Some gauges have a red hand that is used to show minimum or maximum operating pressures, some gauges have two red hands that are used to show both.
  - 2. Most of these gauges have one or two needles, depending on the application.
  - 3. Each gauge has a face that may be read in increments of the unit of measurement.
- C. Bourdon-tube gauges are classified as:
  - 1. Simplex Gauges - have one Bourdon-tube, one needle, and take a pressure indication from one connection.
  - 2. Duplex Gauges - have two Bourdon-tubes, two needles, and indicate readings from two connections. The duplex gauges indicate pressure from two different locations simultaneously.
  - 3. Differential Gauges - are used to measure the difference in pressure from two different locations. They have two Bourdon tubes but only one needle.
  - 4. Vacuum Gauges are used to measure pressures that are below atmospheric pressure. These gauges are normally marked in inches of mercury (in. Hg) or inches of water (in H<sub>2</sub>O).
  - 5. Compound Gauges are used to measure both above and below atmospheric pressure. The compound pressure gauge is normally marked in inches of mercury (in. Hg) and pounds per square inch (PSI).
- III. Temperature Measuring Devices- used to measure temperature.
  - A. Thermometers: The application of the temperature measuring device determines the type of thermometer to use. Liquid in glass thermometers are the oldest, simplest and most widely used for measuring temperature.
    - 1. A liquid in glass thermometer has graduations that may be etched onto the glass or placed on a piece of metal attached to the glass.
    - 2. Temperature measuring devices may read in Celsius or Fahrenheit.
  - B. Bimetallic expansion thermometer uses two dissimilar metals that are fused together.
    - 1. Each metal has a different expansion and contraction rate to temperature change.
    - 2. With a given temperature change, one metal will expand or contract faster than the other.

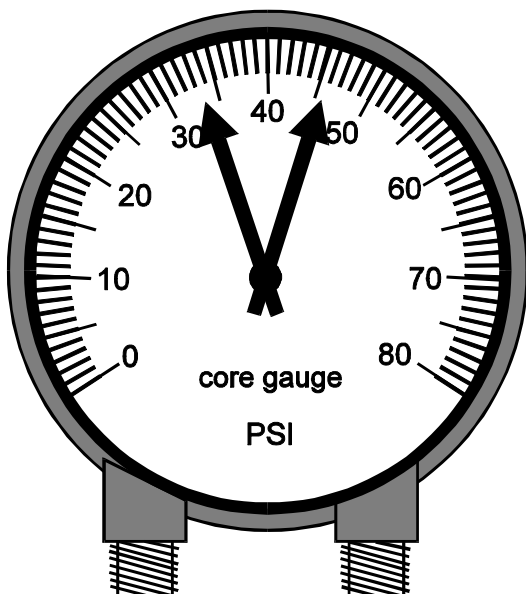
3. The metal is wound into a flat spiral or helix. One end is fixed so it cannot move. The other end is attached to a pointer and is positioned so it moves on a revolving chart.
  - C. Filled-system thermometers are used in locations where the indicating part of the instrument must be placed some distance away from the point where the temperature is to be measured.
    1. This type of thermometer is also known as a distant reading thermometer.
    2. Filled-system thermometer consists of a hollow metal sensing bulb at one end of a small bore tube. The other end is connected to a Bourdon tube or other similar pressure indication that reacts to volume or pressure changes.
    3. The system is filled or partially filled with a fluid that expands or contracts with temperature change.
    4. By this expansion and contraction, the pressure exerted on the gauge moves the needle to indicate the temperature.
  - D. Pyrometers are used to indicate temperatures ranging from 300 degrees to 3000 degrees Fahrenheit.
    1. This type of thermometer is found on diesel and gas turbine engines to measure a range of temperatures.
    2. A pyrometer has a thermocouple and a meter.
      - a) The thermocouple is made up of two dissimilar metals that are joined together.
      - b) An electrical current is created when heat is applied to these metals.
      - c) This electrical current is then sent to a meter.
      - d) The meter converts the electrical current to a temperature reading.
      - e) The hotter the temperature, the more electrical current is received by the meter.
- IV. Liquid Level Indicators:
- A. Direct reading devices:
    1. Sounding tape - a measuring tape that is attached to and wound onto a drum. The tape has a non-sparking plumb bob attached to the end. The tape is measured in feet and inches.
    2. Sounding rules - are made of metal segments joined to fold into compact units. This rule reads in feet and inches.
    3. Sight glass - a vertical glass tube outside a tank that is piped into the tank at the top and bottom. A scale that reads directly in gallons is placed behind the tube to indicate the amount of liquid in the tank.
  - B. Indirect reading devices
    1. Tank Level Indicator (TLI) - is a device that consists of one or more level sensors or transmitters, a measuring circuit, one or more indicators, and a power supply.

- a) The type of sensor that is commonly used by the Navy is the magnetic float type.
- b) The magnetic float type has two major components:
  - (1) Fluid level detection devices- magnetic reed switches installed in tanks to convert the fluid level into an electrical signal. These switches are contained within a stainless steel tube surrounded by a rubber tube.
  - (2) Receiver devices- used to convert electrical signal to the deflections of a pointer on a meter, usually marked in gallons or pounds of fluid.
- 2. Remote Level Indicator- used to indicate the tank level from a central station a distance away from the tanks. This indicator may be connected directly to the tank level sensors or may be connected to another indicator located at another station.

**DIAGRAM SHEET 1-4-4A**

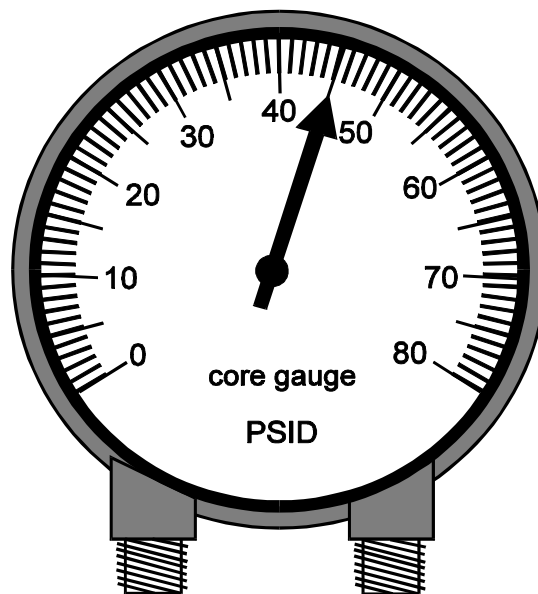
Meters and Gauges

Bourdon Tube Gauges



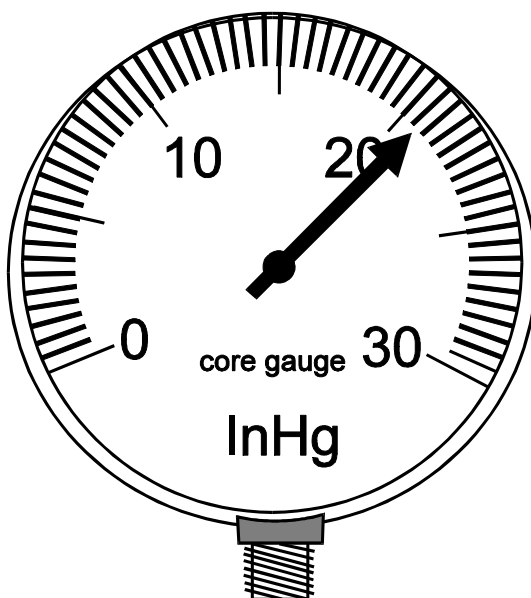
**1A Strainer Inlet/Outlet Pressure**

DUPLEX PRESSURE GAUGE



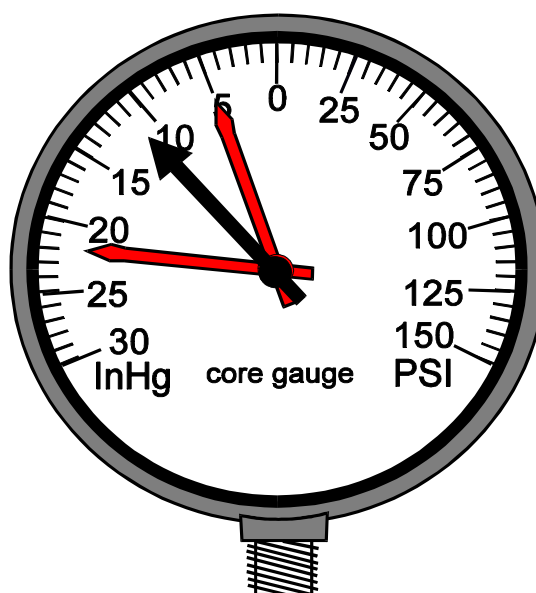
**1A Strainer Differential Pressure**

DIFFERENTIAL PRESSURE GAUGE



**#1 Vacuum Priming Tank**

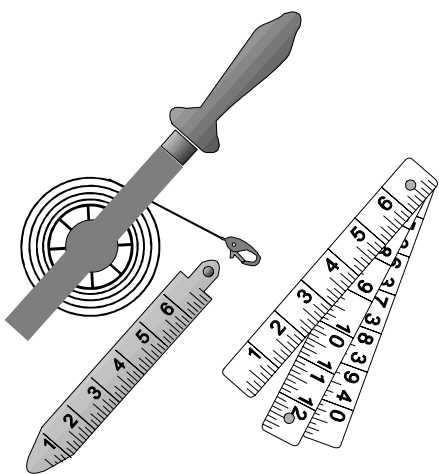
VACUUM GAUGE



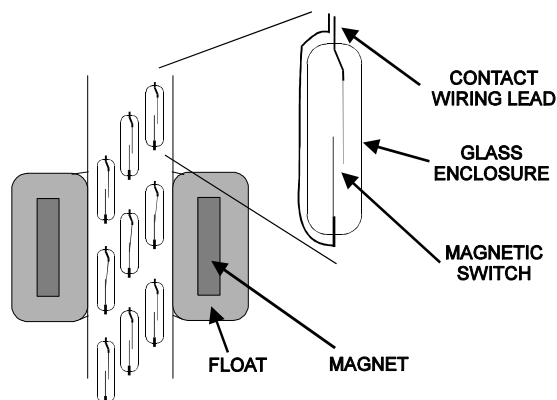
**#1 Fire Pump Suction**

COMPOUND GAUGE

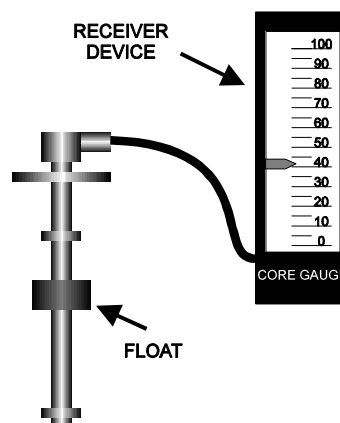
# **DIAGRAM SHEET 1-4-4B** Meters and Gauges



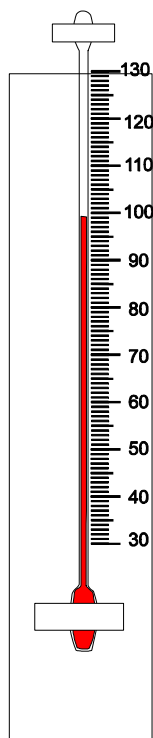
**SOUNDING TAPE  
AND SOUNDING RULE**



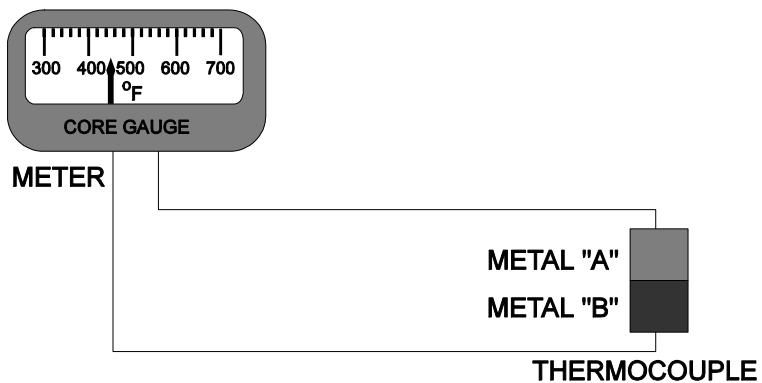
**MAGNETIC REED SWITCHES**



**RECEIVER DEVICE**



**LIQUID-IN-GLASS  
THERMOMETER**



**PYROMETER**